Institute for Cognitive Systems
TUM Department of Electrical and Computer Engineering
Technical University of Munich

Opponent Detection and Localization

Humanoid Robocup Introduction/Advanced Lab

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Chair for Cognitve Systems

Prof. Dr. Gordon Cheng

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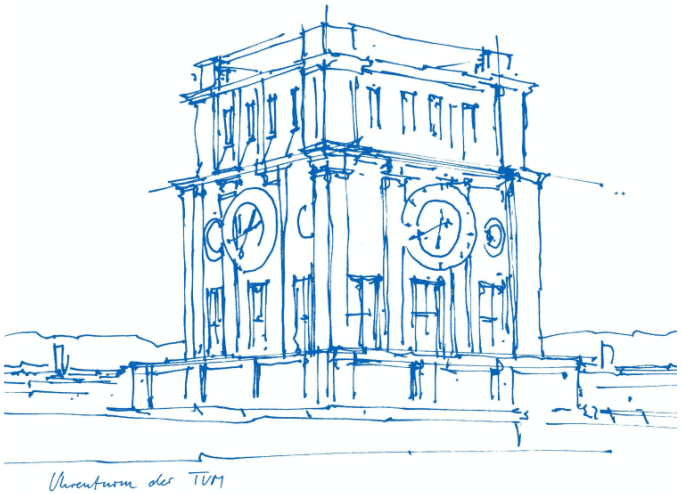

Motivation

- Lack of opponent detection
- No fixed features in robotics (change as different state)
- Can be applied in other fields (like ball detection)

Approach

- More reliable preprocessing
- CNN-based approach
- Open-CV approach

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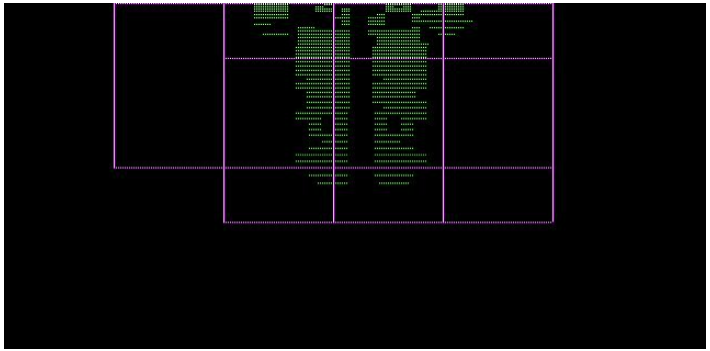
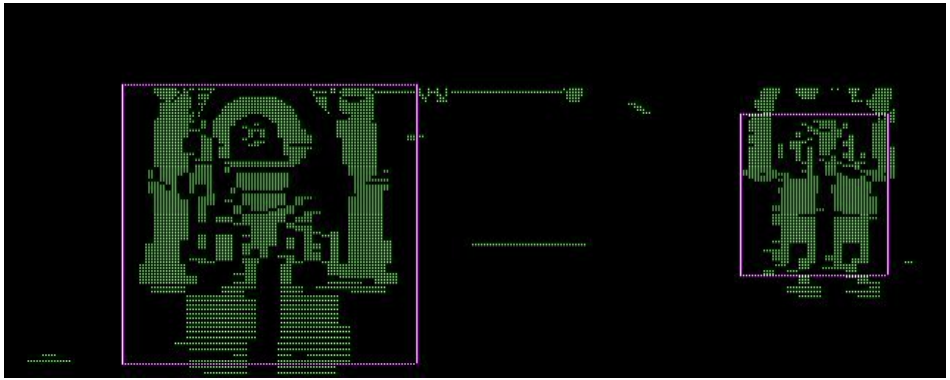
Preprocess Image

Approach:

1. Create filter image
   pixel between edges = 1
1. Use sliding window
   a. Shift by 30 pixel
   b. If sum > threshold
      →valid window
1. Combine valid windows
2. Cut window image





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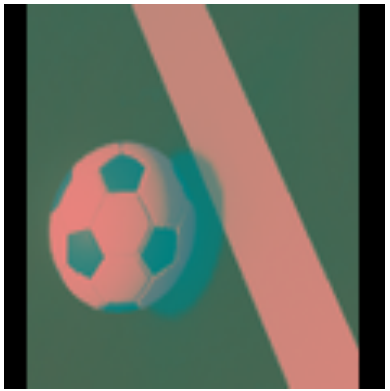
Dataset

- Use the dataset from https://github.com/szemenyeim/ROBO
- Select image with robot after preprocessing

Not Robot : 2016 Pictures



Robot : 2233 Pictures

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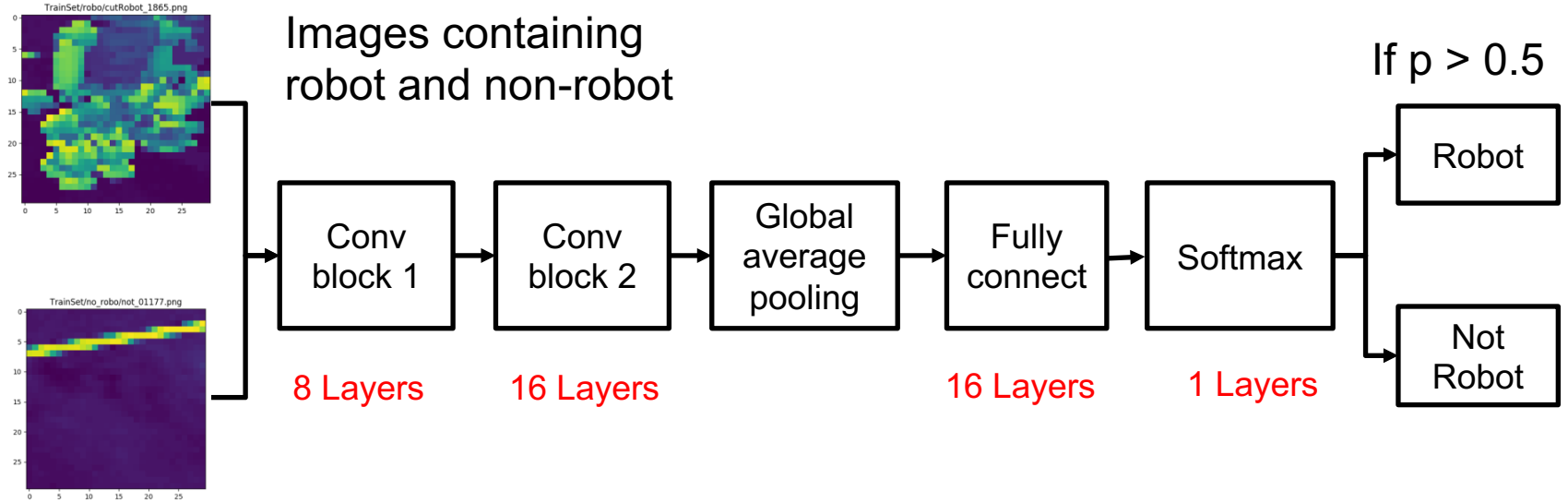
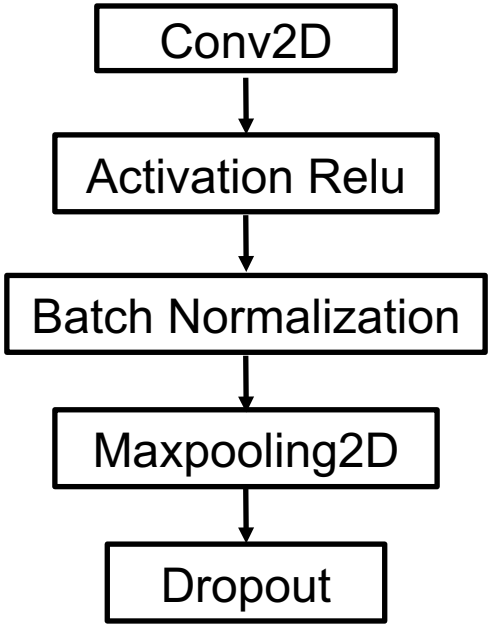
CNN Architecture



CNN Block


Conv2D
Activation Relu
Batch Normalization
Maxpooling2D
Dropout

CNN for Binary Classification

Hyperparameters

- CNN filters: [4, 8], [8, 16], [8, 16, 32], [16, 32, 64], [32, 64, 128]
- FC filters: [8, 1], [16, 1], [32, 1], [64, 1], [128, 1]
- Optimizer: Adam (lr=1e-4, decay=1e-3)
- Loss: Binary cross entropy
- Metrics: Accuracy

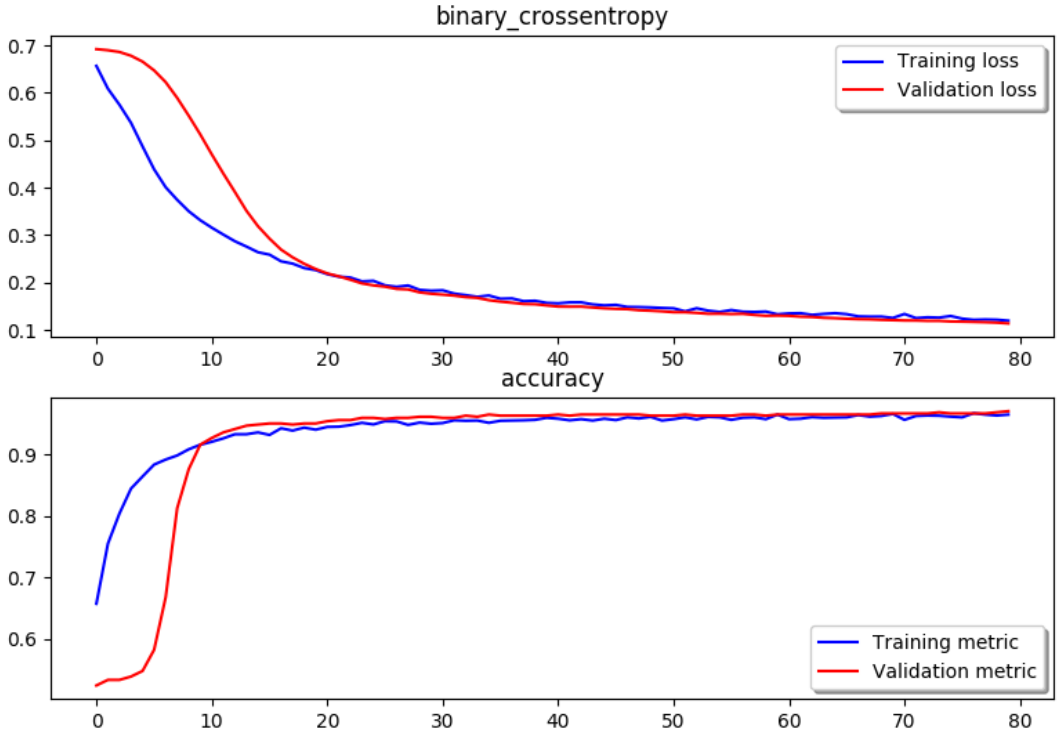
→ Best filter size: [8, 16] [16, 1]

Training Result

Loss:
Training = 0.1197
Validation = 0.1140

Accuracy:
Training = 0.9654
Validation = 0.9710

Test = 0.9738



Test on Real Robot

Time consumption:

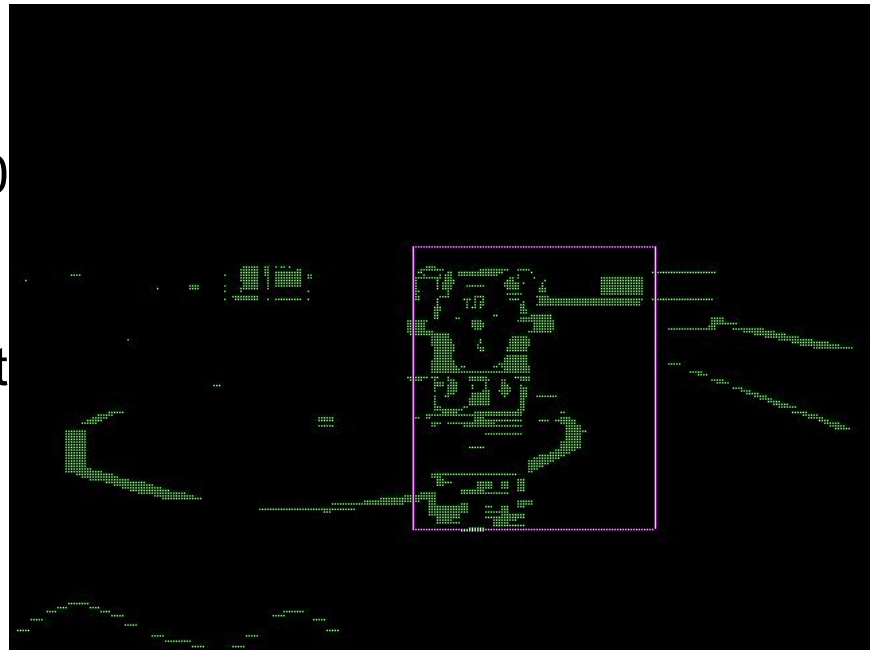
Max Preprocessing = 0.00s

Max Robot detection = 0.0

Problems:

Edge detection not perfect

Light fluctuation

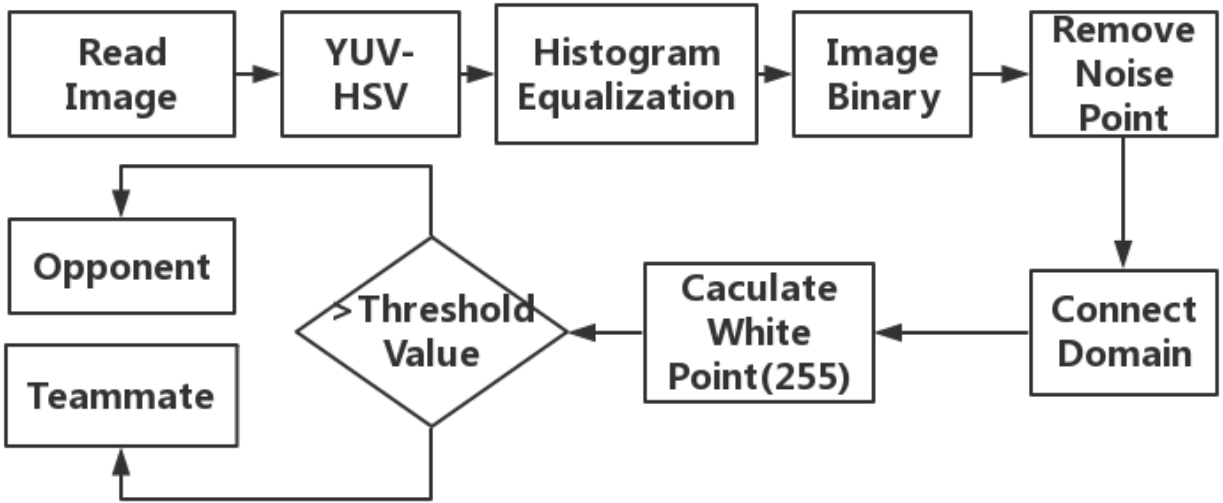


Team Identification

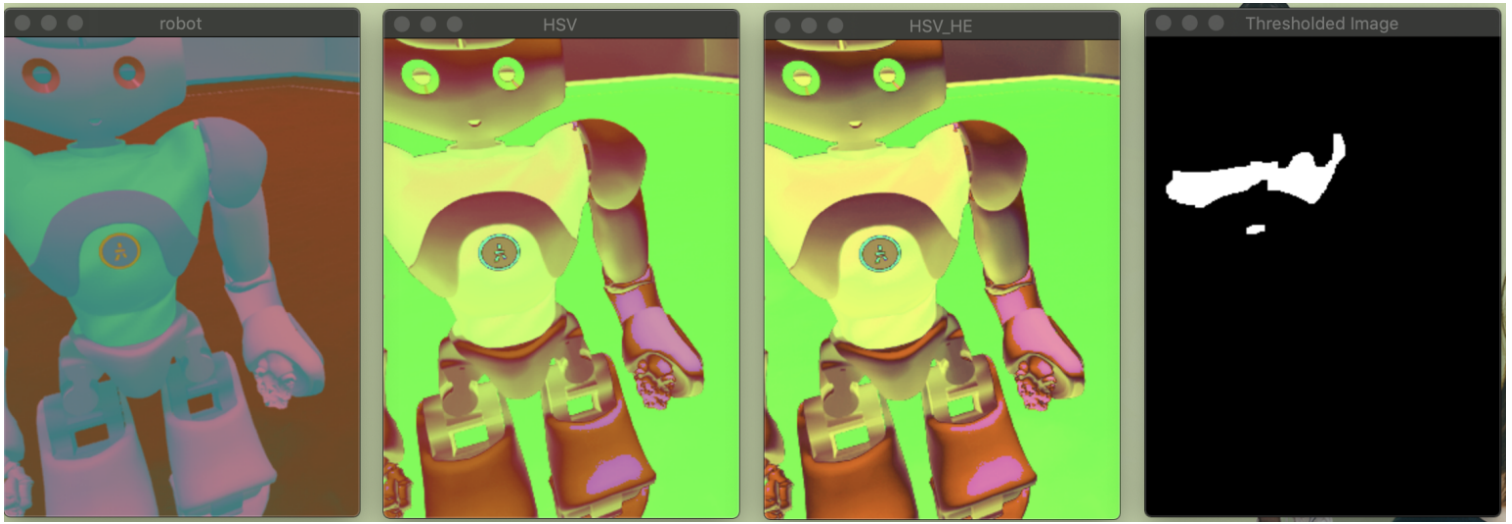
Solutions:

1. Directly use YCrCb

2. Transform YCrCb into HSV



Team Identification



Original Image

HSV Image

HSV after Histogram Equalization

Binary Image

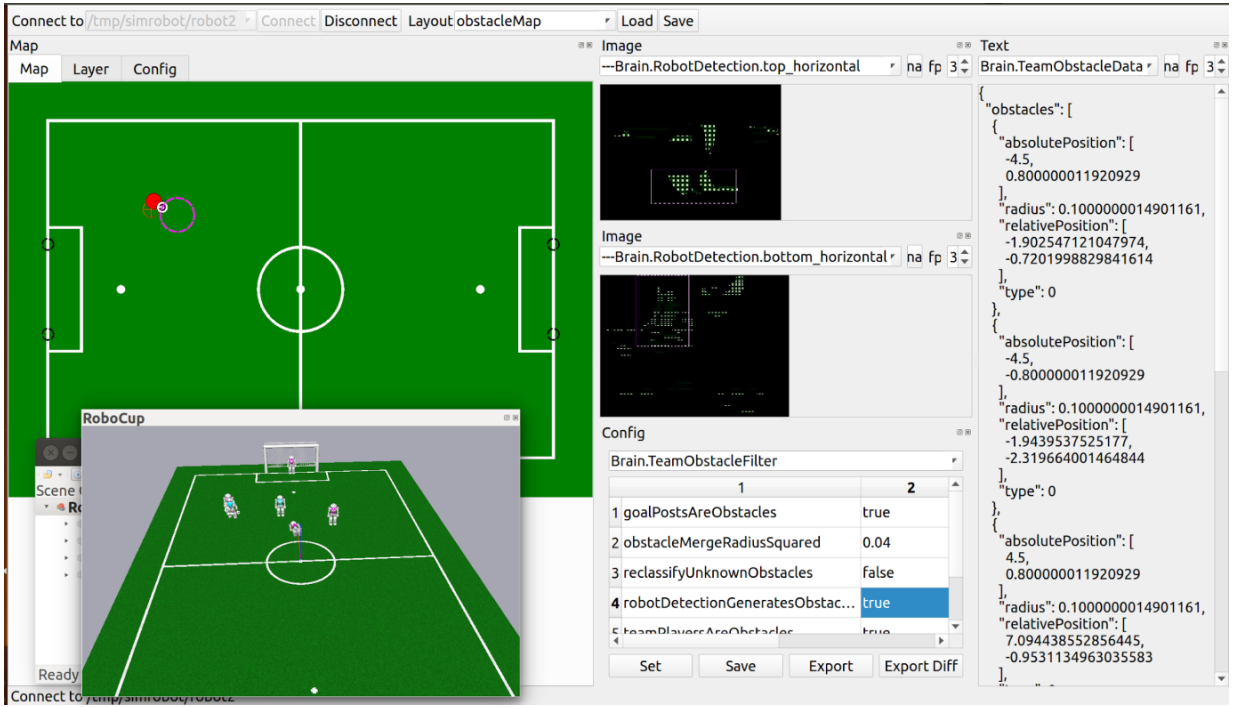
Position Estimate

middle-point of the bottom-line in pixel coordination

Positions of the robots in robot coordination

Pose of the robot in field coordination

Position Estimate



Question?

Future Work and Outlook

Future Work

- More stable purple circle of robot detection in MATE
- Integrate the teammate estimation
- Optimize the memory consumption of the neural network
- Faster the speed of processing

Outlook

- Algorithm which can detect all types of color
- Optimization for reducing the influence of light elements
- More accurate self-positioning

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Parameters

Layer(type)	Output Shape	Param #
conv2d	(None, 28, 28, 8)	80
activation	(None, 28, 28, 8)	0
batch_normalization	(None, 28, 28, 8)	32
max_pooling2d	(None, 14, 14, 8)	0
dropout	(None, 14, 14, 8)	0
conv2d_1	(None, 12, 12, 16)	1168
activation_1	(None, 12, 12, 16)	0
batch_normalization_1	(None, 12, 12, 16)	64
max_pooling2d_1	(None, 6, 6,16)	0
dropout_1	(None, 6, 6,16)	0
global_average_pooling2d	(None, 16)	0
dropout_2	(None, 16)	0
dense	(None, 16)	272
activation_2	(None, 16)	0
dropout_3	(None, 16)	0
dense_1	(None, 1)	17
activate_3	(None, 1)	0

Total Params:

1,633

Trainable Params:

1,585

Non-trainable Params: